Buletin Peternakan 48 (4): 242-247, November 2024

ISSTAP
Indonesian Society for Sustainable Tropical Animal Production

Bulletin of Animal Science

ISSN-0126-4400/E-ISSN-2407-876X Accredited: 36a/E/KPT/2016
http://buletinpeternakan.fapet.ugm.ac.id/

Doi: 10.21059/buletinpeternak.v%vi%i.87329

Evaluation of Fermented Rations Containing *Physalis angulata* (Ciplukan) on the Performance of Male Laying Chickens

Fahmi Setia Maulana[1], Allaily[1,2*], Zulfan[1] and Muhammad Daud[1]

[1]Department of Animal Science, Faculty of Agriculture, Universitas Syiah Kuala, Banda Aceh, Indonesia
[2]Research Centre for Sustainable Production System and Life Cycle Assessment, National Research and Innovation Agency, Tangerang, Indonesia

Article history
Submitted: 26 July 2023
Accepted: 17 November 2023

* Corresponding author:
E-mail: allaily@unsyiah.ac.id

ABSTRACT

The cultivation of male laying chickens still has problems, namely the resulting performance is not maximized. Therefore research using fermented ciplukan plant (*Physalis angulata*) as a feed additive containing antioxidant compounds that function to improve performance needs to be carried out. This study aims to determine the effect of using fermented ciplukan flour on the performance of male laying chicken. This research was conducted at the Animal Husbandry Field Laboratory of the Faculty of Agriculture, Universitas Syiah Kuala, Indonesia. The material for this research was 100 DOC (Day Old Chicks) male laying chicken MB 502 from PT Japfa Comfeed Indonesia. This research method used a completely randomized design (CRD) with 4 treatments. The treatments were: control/without giving ciplukan (T0), giving 0.5% fermented ciplukan (T1), giving 0.75% fermented ciplukan (T2) and giving 1% fermented ciplukan (T3). Each treatment was repeated 5 times, each repetition consisting of 5 chickens. The parameters measured included ration consumption, body weight gain, final body weight, ration conversion and ration efficiency. Data were analyzed using Analysis of Variance, followed by Duncan's Multiple Range test. The results showed that the addition of fermented ciplukan flour in the ration had no significant effect on the consumption of male laying chicken. In conclusion, real treatment resulted in lower performance compared to commercial rations. However, T1, which is 0.5% ciplukan, tends to produce better performance.

Keywords: Ciplukan, Feed additive, Male laying chickens, Performance

Introduction

Male laying chickens are a by-product of the production of the commercial laying chickens hatchery industry. Male laying chickens are generally not used because they are considered to have no economic value. Laying chickens have the potential to be developed as meat-producing livestock to meet the demand for meat in Indonesia. Male laying chickens can reach an average body weight at the end of 6 wk of age ranging from 1115.6 – 1187.5 g/bird (Daud *et al*., 2017). Chicken performance can be improved by maximizing the factors that can maximize production results.

Factors that affect chicken production are, the fulfillment of nutritional needs and continuous availability of feed during the rearing period. Feed is basically to meet basic needs, form cells, body tissues, and for production purposes. The availability of feed in a livestock business is as important as the provision of chicken seeds. Widodo (2018) said the cost of feed in the broiler farming business is a very large percentage, which is 60% – 70% of production costs. The problem experienced in raising male laying chickens is that the production performance is not maximized, while the amount of feed given has been fulfilled. One of the causes of production that has not been maximized is inefficient feeding management (Primacitra *et al.,* 2014). In addition, the cost of commercial feed in Indonesia is very expensive. To overcome this, it is necessary to emphasize the cost of feed and efforts to improve feed quality, namely by using additive materials that have good nutritional content so that male laying chickens can produce optimally.

One of the potential feed additives is the ciplukan plant (*Physalis angulata*). However, its benefits and uses are not widely known within the community. Ciplukan is an annual plant that can cure various diseases and is a plant with split seeds that can grow in the highlands, so it is easy to find in sufficient land or places. sun and loose soil (Hutagaol, 2019). Ciplukan is a feed ingredient that is a source of phytogenic additives that can increase feed use efficiency and acceptability as

well as increase metabolic processes in livestock (Daud *et al*., 2021b). Ciplukan contains antioxidant compounds such as alkaloids, saponins, steroids, triterpenoids, and flavoanoids which function to prevent cells from damage caused by free radicals (Nuranda *et al.,* 2016). The ciplukan plant has a high crude protein content of 27.79%, 7.08% crude fiber and 3.43% fat (Daud *et al*., 2021a). The high protein content in ciplukan will contribute to meeting the protein needs of poultry.

However, ciplukan also has a limiting factor, namely the presence of anti-nutrients such as tannins. To reduce the levels of antinutrients in feed ingredients can be using fermentation (Khusro *et al.,* 2020). Given this, it is necessary to review the potential of the ciplukan plant (*Physalis angulata*) which has not been widely used so that it can be used as additional feed in the form of fermented feed to improve the performance of male laying chickens. This study aims to determine the effect of the treatment of rations containing fermented ciplukan flour on the performance of male laying chicken.

Materials and Methods

Place and time of research

This research was conducted at the Livestock Field Laboratory at Syiah Kuala University, Darussalam-Banda Aceh. This research was carried out for 7 wk, from February 3 to March 24 2023.

Research material

The material used was 100 DOC (Day Old Chicks) male laying chicken MB 502 from PT. Japfa Comfeed Indonesia, ciplukan flour, vivo 511 commercial feed from PT. Charoen Pokphand Indonesia, corn, rice bran, coconut meal, soybean meal, fish meal, shellfish meal, top mix, Gumboro vaccine, vitastress, commercial inoculants EM4, molasses, disinfectant, lime, litter, plastic. The equipment used in this study consisted of cages, heating bulbs, scales, feeders, drinkers, and diskmills. Ethics approval : This research has adhered to all national regulations and institutional policies.

Research cage

The cages used for this study were postal cages with litter as floor mats, then 20 units of cages were partitioned off with a size of 1 × 1 m. To sterilize the cage from viruses and bacteria, liming and spraying disinfectant was carried out on the cage and the equipment used in this study. Next, perform litter sowing and install lights, feeders, and drinkers.

Making fermented ciplukan flour

The parts used in the manufacture of ciplukan flour consist of stems, leaves and fruit. Stems, leaves and fruit are aerated and then dried in indirect sunlight. Then after drying, grind it into flour using a disk mill. After achieving a flour-like consistency, ciplukan flour is combined with the EM4 solution and molasses which is evenly sprayed using a sprayer. It is the placed into plastic containers and sealed with rubber. After these stages, the ciplukan flour is fermented using an anaerobic system for 7 d.

Ration preparation

The ration ingredients used consist of corn, rice bran, coconut meal, soybean meal, fish meal, shellfish meal and top mix. The rations are prepared according to the nutritional needs of male laying hens. The composition of the rations given can be seen in Table 1.

Research design

This study used a completely randomized design (CRD). There were 4 treatments in this study with each treatment having 5 repetitions with 20 experimental units, where each unit consisted of 5 chickens so the total sample used in this study was 100 chickens. T0: control/without adding ciplukan, T1: giving 0.5% ciplukan, T2: giving 0.75%, and T3: giving 1%. The data obtained were analyzed using Analysis of Variance (ANOVA) and the results were significantly different between the treatments followed by Duncan's Multiple Range Test. Parameters observed included: ration

Table 1. Composition and nutritional content of the ration

Feed ingredients	Treatment			
	T0	T1	T2	T3
Commercial feed[2]	100	0	0	0
Rice bran[1]	0	27	27	27
Corn[1]	0	40	40	40
Coconut meal[1]	0	9.5	9.5	9.5
Soybean meal [1]	0	13	13	13
Fish meal [1]	0	7	7	7
Shellfish meal [1]	0	3	3	3
Top Mix[1]	0	0.5	0.5	0.5
Total	100	100	100	100
Kandungan zat nutrisi				
Crude protein (%)[3]	21-23	16.53	16.53	16.53
Crude fat (%)[3]	5.00	4.06	4.06	4.06
Ash (%)[3]	7.00	7.08	7.08	7.08
Moisture (%)[3]	13.00	5.36	5.36	5.36
Carbohydrate (%)[3]	52.00	66.97	66.97	66.97

[1] Baye *et al*., 2015
[2] Vivo 511 label
[3] Results of proximate analysis at the Food Products Analysis Laboratory, Faculty of Agriculture, Syiah Kuala University.

consumption (g/bird/wk), body weight gain (g/bird/wk), final body weight (g/bird), ration conversion and feed efficiency.

Results and Discussion

Ration consumption

The results of the analysis of variance revealed that it had no effect ($p>0.05$) on the consumption of male laying chicken rations (Tabel 2). The average consumption of male laying chickens during 7 wk of rearing ranged from 244.09 – 286.96 g/bird/wk. The lowest ration consumption was observed in T0 with an average value of 244.09 g/bird/wk. The highest ration consumption was in the T2 treatment with an average value of 286.96 g/bird/wk.

Sio *et al*. (2015) states that growth in chickens varies depending on the type of chicken, sex, temperature of the cage, quality, and quantity of feed. Chickens that consume commercial feed will eat less but can convert feed into body weight properly, so that chickens will consume feed according to their body weight needs. Other factors that affect ration consumption are body weight, ambient temperature, ration palatability, production phase and age of livestock (Mitra *et al*., 2014). Chickens fed treated feed consumed more feed because the nutritional quality of the feed, such as protein, could not meet the needs of the chickens. Differences in protein content cause chickens to consume more rations if their energy needs are not fulfilled (Suprijatna, 2005).

Body weight gain

The body weight gain of male laying chickens during the 7 wk rearing period given fermented ciplukan flour at different levels can be seen in Table 4. The results of the analysis of variance showed that the treatments had a very significant effect ($p<0.01$) on reducing the body weight gain of male laying chickens. The average value of body weight gain for male laying chickens in T0 was the with an average value of 101.41 g/bird/wk.

The results of this study indicated that there were significant differences ($p<0.01$) between the control feed and the ciplukan rations. Chickens fed commercial feed have a higher body weight gain than chickens fed ciplukan rations, this is because commercial feed has good feed quality and complete nutritional content. In accordance to Zulkarnaen (2013) that feed that has a complete and precise nutritional content according to the needs of chickens will provide a good value for body weight gain. The growth of chicken body tissue is dependent on adequate nutrition and nutrients. Commercial feed can fulfill the requirements for the weight gain of chickens.

Chickens fed fermented ciplukan flour ration had an average body weight gain of 46.63 – 53.06 g/bird/wk, which was lower than the study of

Table 2. Average feed consumption of male laying chicken (g/bird/week) ± stdev

Repetition	Treatments			
	T0	T1	T2	T3
1	256.26	334.39	284.66	253.66
2	241.11	255.49	310.54	251.11
3	239.60	257.34	283.29	249.86
4	246.38	256.29	302.25	254.40
5	237.11	247.49	254.03	310.32
Average	244.09±7.60	270.20±36.10	286.96±21.76	263.87±26.03

T0 = Control feed (commercial feed vivo-511 without the addition of fermented ciplukan flour), T1 = Basal ration + 0.5% fermented ciplukan flour, T2 = Basal ration + 0.75% fermented ciplukan flour, T3 = Basal ration + 1% fermented ciplukan flour.

Table 3. Consumption of rations in each treatment (g/bird)

Week	Treatments			
	T0	T1	T2	T3
1	66.44	70.14	65.62	62.85
2	102.20	133.90	134.99	131.93
3	204.24	214.96	222.81	215.56
4	235.68	228.67	239.46	234.72
5	325.30	378.44	390.07	366.53
6	379.59	415.21	470.01	413.65
7	395.20	450.07	485.75	421.85

T0 = Control feed (commercial feed vivo-511 without the addition of fermented ciplukan flour), T1 = Basal ration + 0.5% fermented ciplukan flour, T2 = Basal ration + 0.75% fermented ciplukan flour, T3 = Basal ration + 1% fermented ciplukan flour.

Table 4. Average weight gain for male laying chickens (g/bird/week) ± stdev

Repetition	Treatments			
	T0	T1	T2	T3
1	104.14	60.86	37.04	46.43
2	105.71	49.00	55.83	48.29
3	99.29	52.00	55.43	49.86
4	97.76	55.57	31.14	51.57
5	100.14	47.86	53.71	50.07
Average	$101.41±3.37^{b}$	$53.06±5.29^{a}$	$46.63±11.66^{a}$	$49.24±1.96^{a}$

T0 = Control feed (commercial feed vivo-511 without the addition of fermented ciplukan flour), T1 = Basal ration + 0.5% fermented ciplukan flour, T2 = Basal ration + 0.75% fermented ciplukan flour, T3 = Basal ration + 1% fermented ciplukan flour.

Daud *et al*. (2017) which obtained an average body weight gain of 178.1 – 190.1 g/bird/week. The low body weight gain of chickens in T1, T2 and T3 treatment is thought to be due to the presence of anti-nutritional compounds such as tannins contained in ciplukan flour. Nangoy *et al.* (2022) stated that tannins can bind to proteins to form complex bonds so that these proteins are difficult to digest. Anti-nutritional compounds can prevent chickens from properly digesting feed, resulting in nutritional deficiencies. The increased use of ciplukan in the ration means that the tannins contained in the ration also increase. These results indicate that the use of fermented ciplukan flour at levels of 0.5%, 0.75%, and 1% can significantly reduce the body weight gain of male laying chickens.

Final body weight

The results of the analysis of variance showed that the treatment had a very significant effect ($p<0.01$) on reducing the final weight of male laying chickens in this study. Data on the final body weight of male laying chickens fed fermented ciplukan flour can be seen in Table 6. The average final body weight in this study ranged from 358.82-743.46 g/bird, where the best average final body weight was obtained in treatment T0 with a value of 743.46 ± 23.81 g/bird.

The final body weight of chickens that received the ciplukan rations was significantly lower ($p<0.01$) than the control diet. The final body weight in this study was lower than the results of Nova (2017) research which obtained an average final body weight of 735.63 – 762.08 g/bird during 7 wk of maintenance. This is suspected of the presence of tannins in ciplukan which can inhibit the absorption of nutrients in chickens. If the process of absorption of nutrients by chickens is not optimal it is feared that it can result in low body weight. Chickens will produce high body weight if the absorption of nutrients is carried out optimally because the process of absorption of nutrients is directly related to the growth of chickens (Kastalani *et al.,* 2021).

The final body weight of male laying chickens fed rations with the addition of fermented ciplukan flour at levels of 0.5%, 0.75%, and 1% did not show any differences between the treatments, but had significant differences with the chickens fed commercial feed. This shows that chickens fed commercial feed have a better final body weight than chickens fed rations with the addition of fermented ciplukan flour. Chickens that were given the treatment experienced weight gain barriers, resulting in a significantly lower final body weight.

Convertion ratio

The results of the analysis of variance showing patterns had a very significant effect ($p<0.01$) on increasing the conversion of rations to male laying chickens. Feed conversion ratio of male laying chickens given fermented ciplukan flour can be seen in Table 7. The smallest average ration conversion was obtained in treatment T0 with an average value of 2.30 and the highest average ration conversion value was in treatment T2 with an average value of 5.90.

The ration conversion value is related to ration consumption and body weight of chickens. Feed conversion is an indicator to assess the ability of chickens to convert the ration consumed into body weight (Islam *et al.,* 2022). The smaller the conversion number, the better the ration conversion value. The high value of ration conversion in this study is suspected because the chickens consumed the ration but were not followed by high body weight gain. This is in line with the opinion of Rasyaf (2008) that the factors that affect the conversion value are ration consumption and body weight gain.

Laying chickens fed commercial feed had a lower ration conversion than chickens fed a basal ration with the addition of fermented ciplukan flour. Chickens that consume commercial feed have better ration conversion than chickens that

Table 5. Body weight gain for each treatment (g/bird)

Week	Treatments			
	T0	T1	T2	T3
1	36.88	13.2	13.0	11.6
2	98.04	37.8	33.9	34.6
3	191.4	64.1	55.6	57.0
4	292.8	112.0	101.0	105.0
5	417.0	173.0	153.0	162.0
6	564.3	258	233.0	244.0
7	709.9	371	326	345.0

T0 = Control feed (commercial feed vivo-511 without the addition of fermented ciplukan flour), T1 = Basal ration + 0.5% fermented ciplukan flour, T2 = Basal ration + 0.75% fermented ciplukan flour, T3 = Basal ration + 1% fermented ciplukan flour.

Table 6. Mean final body weight of male laying chickens (g/bird) ± stdev

Repetition	Treatments			
	T0	T1	T2	T3
1	762.00	460.00	291.30	358.00
2	774.00	377.00	423.80	373.00
3	730.00	398.00	420.00	382.00
4	716.30	423.00	250.00	397.00
5	735.00	368.00	409.00	382.50
Average	743.46±23.81[b]	405.20±37.25[a]	358.82±81.98[a]	378.50±14.33[a]

T0 = Control feed (commercial feed vivo-511 without the addition of fermented ciplukan flour), T1 = Basal ration + 0.5% fermented ciplukan flour, T2 = Basal ration + 0.75% fermented ciplukan flour, T3 = Basal ration + 1% fermented ciplukan flour.

Table 7. Average feed conversion ratio ± stdev of chickens given treated feed

Repetition	Treatments			
	T0	T1	T2	T3
1	2.35	5.09	6.84	4.96
2	2.18	4.74	5.13	4.71
3	2.30	4.53	4.72	4.58
4	2.41	4.24	8.46	4.49
5	2.26	4.71	4.35	5.68
Average	2.30±0.09[b]	4.66±0.31[a]	5.90±1.72[a]	4.88±0.48[a]

T0 = Control feed (commercial feed vivo-511 without the addition of fermented ciplukan flour), T1 = Basal ration + 0.5% fermented ciplukan flour, T2 = Basal ration + 0.75% fermented ciplukan flour, T3 = Basal ration + 1% fermented ciplukan flour.

Table 8. Average ration efficiency of male laying chickens (%) ± stdev

Repetition	Treatments			
	T0	T1	T2	T3
1	42.48	19.65	14.62	20.16
2	45.86	21.08	19.49	21.22
3	43.52	22.09	21.18	21.84
4	41.53	23.58	11.82	22.29
5	44.28	21.24	23.00	17.61
Average	43.54±1.66[b]	21.53±1.44[a]	18.02±4.66[a]	20.62±1.87[a]

T0 = Control feed (commercial feed vivo-511 without the addition of fermented ciplukan flour), T1 = Basal ration + 0.5% fermented ciplukan flour, T2 = Basal ration + 0.75% fermented ciplukan flour, T3 = Basal ration + 1% fermented ciplukan flour.

consume rations with the addition of fermented ciplukan flour. This shows that the use of ciplukan flour does not provide a good conversion value for male laying chickens.

Rations efficiency

The average percentage efficiency of the male laying chickens' ration of all treatments can be seen in Table 8. Based on the results of the analysis of variance analysis of the male laying chickens' ration efficiency, it was shown that the treatment had a very significant effect ($p<0.01$) on reducing the efficiency of the ration. The average efficiency of the rations in this study ranged from 18.02% – 43.54%. The best ration efficiency average was in treatment T0 with an average value of 43.54%, while the lowest average ration efficiency was in treatment T2 with an average value of 18.02%.

The results of this study indicate that the average efficiency value of the ration added with fermented ciplukan flour is categorized as low, because the efficiency of the ration is said to be good if it reaches a value of 50% or more. This is by the opinion of Craig and Helfrich (2002) that good feed has a feed efficiency value of more than 50% or close to 100%. The more nutrients that can be utilized by chickens, the higher the efficiency value of the ration. The more nutrients in the feed that are hydrolyzed and easily absorbed, the higher the feed utilization efficiency (Rachmawati *et al*., 2020).

The ration efficiency between treatments given fermented ciplukan flour showed a number that was not much different from the range of 18.02% – 21.53%, but tended to be much different from the treatment given commercial feed, namely 43.54%. This shows that the use of commercial feed produces better ration efficiency than chickens fed with the addition of fermented ciplukan flour. This means that the addition of fermented ciplukan flour into the ration was not used efficiently by male laying chickens.

Conclusion

Based on the results of the study it can be concluded that the real treatment suppressed the performance of male and T1 laying chickens tended to give good performance compared to other treatments.

Conflict of interest

This research has no conflict of interest with any financial organization regarding the material discussed in this manuscript.

Funding statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgments

The author would like to thank those who helped in the research, both in the form of material support and moral support.

Author's contribution

FSM contributed to the implementation of the research, data collection, data analysis, and manuscript drafting. A played a role in research design, data collection, contributed to writing, and critically revised the manuscript. MD was involved in formulating the research concept, data analysis, and contributed to the drafting and editing of the manuscript. Z contributed to reviewing and analyzing the research data.

References

Baye, A., F. N. Sompie, B. Bagau, and M. Regar. 2015. Penggunaan tepung limbah ikan

dalam ransum terhadap performa broiler. J. Zootek 35: 96-105.

Craig, S. and L. A. Helfrich. 2002. Understanding fish nutrition, feeds and feeding. Extension Service Publication. Virginia State University, USA.

Daud, M., Z. Fuadi, and Mulyadi. 2017. Performa dan persentase karkas ayam ras petelur jantan pada kepadatan kandang yang berbeda. J. Agripet. 17: 67-74.

Daud M., M. A. Yaman, Y. Usman, and Y. Aqmarina. 2021a. Potential of ciplukan extract (*Physalis angulata* L.) and patchouli waste (*Pogostemon patchouli pellet*) as alternative sources of phytogenic feed additive. Earth Environ. Sci. 677: 1-8.

Daud, M., M. A. Yaman, Y. Usman, and C. R. Maulida. 2021b. The effect of ciplukan, betel, moringa and patchouli waste extract as phytogenic feed additive and their effect on broiler performance. Adv. Biol. Sci. Res. 21: 287-291.

Hutagaol, W. V. 2019. Uji efek antibakteri ekstrak etanol daun ciplukan (Physalis angulata L.) terhadap pertumbuhan bakteri *Staphylococcus aureus.* Politeknik Kesehatan Kemenkes Medan: 1-41.

Islam, A., M. Daud, and Zulfan. 2022. Pengaruh penggunaan tepung ciplukan (*Physalis angulata*) dalam ransum terhadap peforma puyuh jantan (*Coturnix-coturnix japonica*). J. Ilmiah Mahasiswa Pertanian 7: 220-225.

Kastalani, M. E. Kusuma, Herlinae and Yemima, 2021. Pengaruh penambahan pakan berbahan dasar maggot dan dedak padi pada pakan basal terhadap bobot hidup, karkas dan giblet ayam broiler. ZIRAA'AH. 46: 44-52.

Khusro, A., A. Sultan, G. Abbas, M. A. Nisar, S. Ahmad, and Y. Li, 2020. Impact of EM-4 fermentation on the reduction of tannin and polyphenol contents in the feed of meat ducks. Anim. Sci. J. 91: 313- 331.

Mitra, H. T., H. Yurmiaty and Mansyur, 2015. Pengaruh pemberian tepung daun indigofera sp terhadap konsumsi, pertambahan bobot badan dan efisiensi ransum kelinci peranakan New Zealand white. Students e-Journals. 4: 1-11

Nangoy, F. J., M. C. Kumurur, L. S. M. Tangkau, and C. L. Sarajar, 2022. penggunaan tepung limbah biji alpukat sebagai sumber antioksidan alami dalam ransum terhadap performa ayam broiler. Zootec 42: 245-253.

Nova, K., 2017. Performa ayam jantan tipe medium dengan persentase pemberian ransum yang berbeda antara siang dan malam. Lampung, Politeknik Negeri Lampung: 307-312.

Nuranda, A., C. Saleh, and B. Yusuf, 2016. Potensi tumbuhan ciplukan (*Physalis angulata Linn*) sebagai antioksidan alami. J. Atomik 1: 5-9.

Primacitra, D. Y., O. Sjofjan and M. H. Natsir, 2014. Pengaruh penambahan probiotik (*Lactobacillus sp*.) dalam pakan terhadap energi metabolis, kecernaan protein dan aktivitas enzim burung puyuh. J. Ternak Tropika. 15: 74-79.

Rachmawati, D., J. Hutabarat, E. N. Dewi, and S. Windarto. 2020. Suplementasi enzim papain dalam pakan terhadap performa pertumbuhan, fisiensi pemanfaatan pakan dan kelulushidupan udang vaname (*Litopenaeus Vannamel*). J. Mar. Res. 9: 215-222.

Rasyaf, M. 2008. Panduan beternak ayam pedaging. Penebar Swadaya, Jakarta.

Sio, A. K., O. R. Nahak and A. A. Dethan. 2015. Perbandingan penggunaan dua jenis ransum terhadap pbbh, konsumsi ransum dan konversi ransum ayam broiler. J. Anim. Sci. 1: 1-3.

Suprijatna, E. 2005. Pengaruh protein ransum saat priode pertumbuhan terhadap performans produksi telur saat priode produksi pada ayam ras petelur tipe medium. J. Indon. Trop. Anim. Agric. 30: 119-126.

Widodo, E., 2018. Ilmu nutrisi unggas. UB Press, Malang, Indonesia.

Zulkarnaen, D. 2013. Lebih sukses dan untung beternak ayam broiler. Daffa Publishing, Surabaya.